U.S. DEPARTMENT OF ENERGY

March 1–5, 2010

INFORMATION
Management Conference

San Antonio, Texas

Using Innovative and Agile IT Solutions to Enable DOE's Evolving Missions

Best Practices and Emerging Trends

Two demonstration projects with Innovative control strategies

- Use of wireless sensors to control Data Center Cooling
- Integrating IT and building control

Wireless controls: significant results

- **Reduced fan energy by 66%**
- **Lowered total energy by 21.3%**
- **Saves 475,000 kWh/yr**
- **Eliminates >400 tons CO_2/yr**
- **Payback in 3.1 years**
- **Bottom-line savings: $42,722**

Demonstration goals

- **Demonstrate** wireless, mesh-network technology to directly control air handlers.
- **Analyze** supervisory software and hardware.
- **Eliminate** over-cooling caused by fighting controls.
- **Examine** air management best-practices.
- **Ensure** CRAH unit operational redundancy.

Data center

Description:

- **10,000 Sq Ft**
- **12 CRAH cooling units**
- **135 kW load**

Challenges:

- **Over-provisioned**
- **History of fighting**
- **Manual shutoff not successful**

Solution:

- **Intelligent control software with inlet air sensing**

INFORMATION Management Conference

Project sequence:

- **Establish baseline**

- **Adjust floor tiles**

- **Install Variable Frequency Drives (VFDs)**

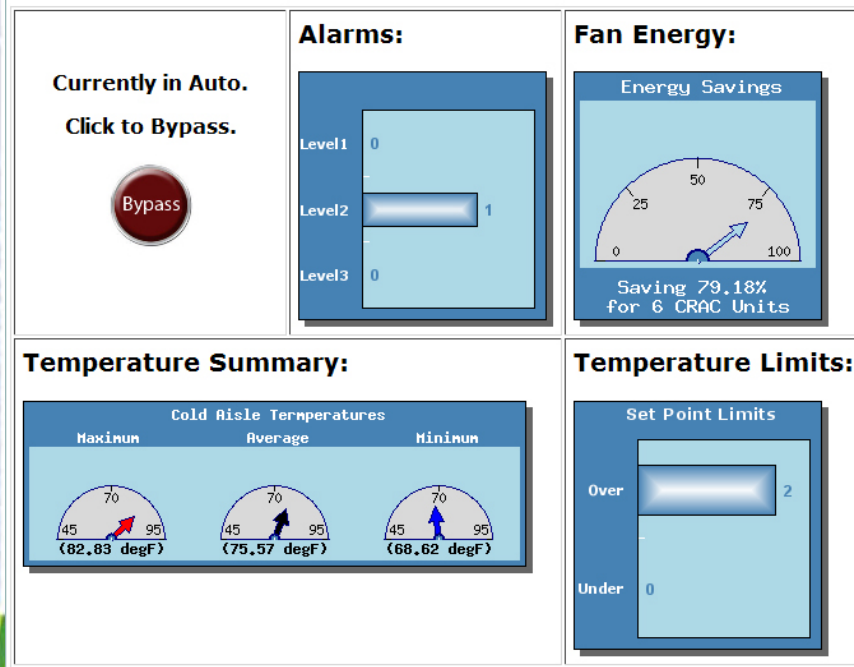- **Install supervisory control software**

- **Isolate hot-aisles**

- **Blank racks**

- **50 wireless temperature sensors (Dust Networks radios)**
- **Intelligent control software**

FACS Dashboard:

Alarms:
- Level1: 0
- Level2: 1
- Level3: 0

Currently in Auto. Click to Bypass.

Bypass

Fan Energy:
Energy Savings
Saving 79.18% for 6 CRAC Units

Temperature Summary:
Cold Aisle Temperatures
- Maximum: (82.83 degF)
- Average: (75.57 degF)
- Minimum: (68.62 degF)

Temperature Limits:
Set Point Limits
- Over: 2
- Under: 0

89 °F (31.7 °C)

63 °F (17 °C)
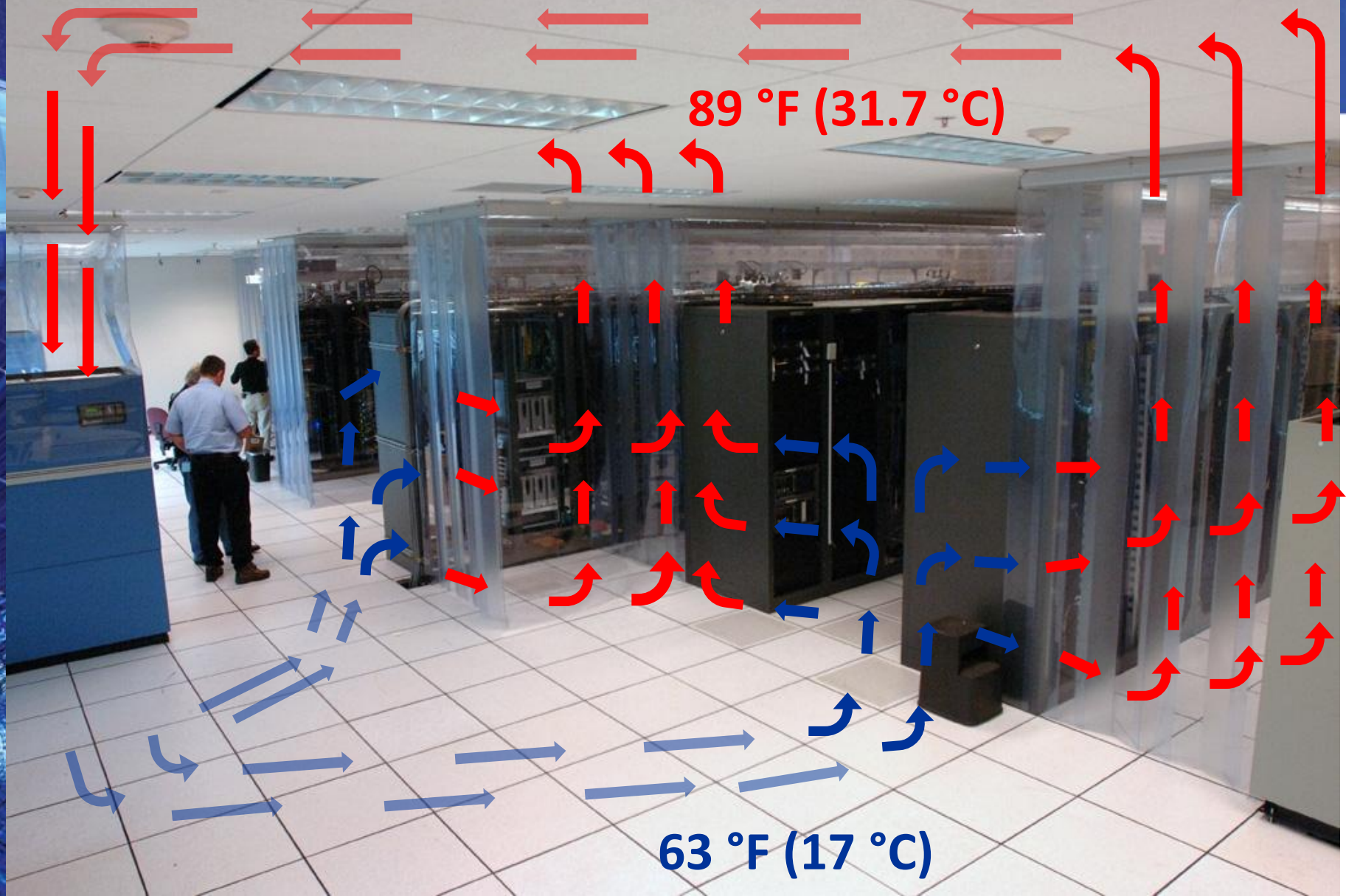
Smart software: learns about curtains

CRAH 3 influence at start

CRAH 3 influence after curtains
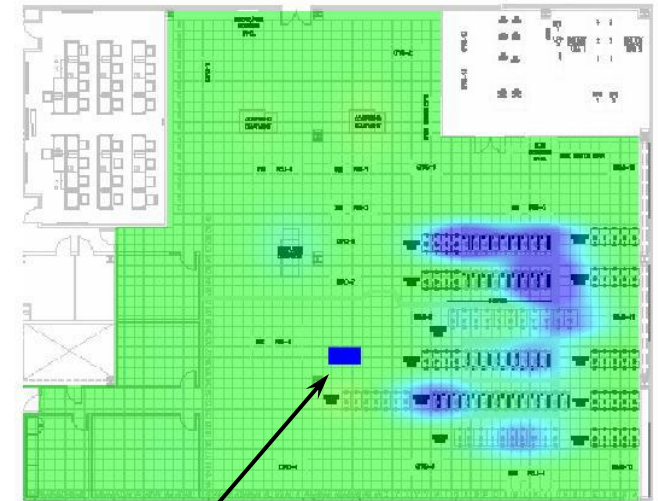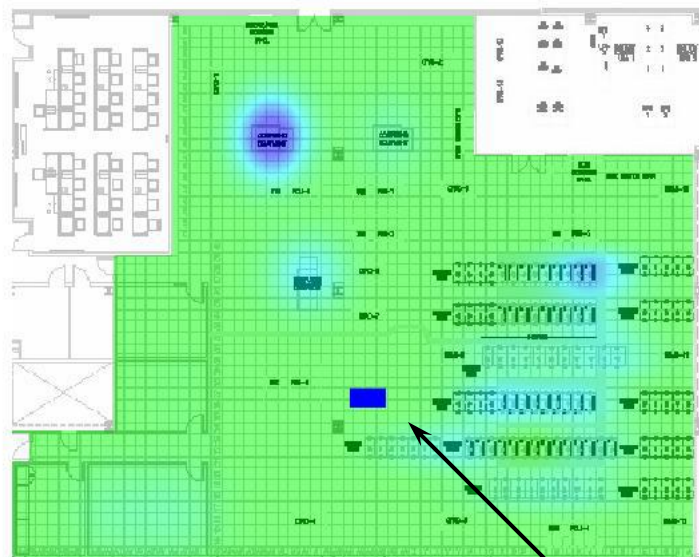
CRAH-03

Effect on cold aisle temperatures:
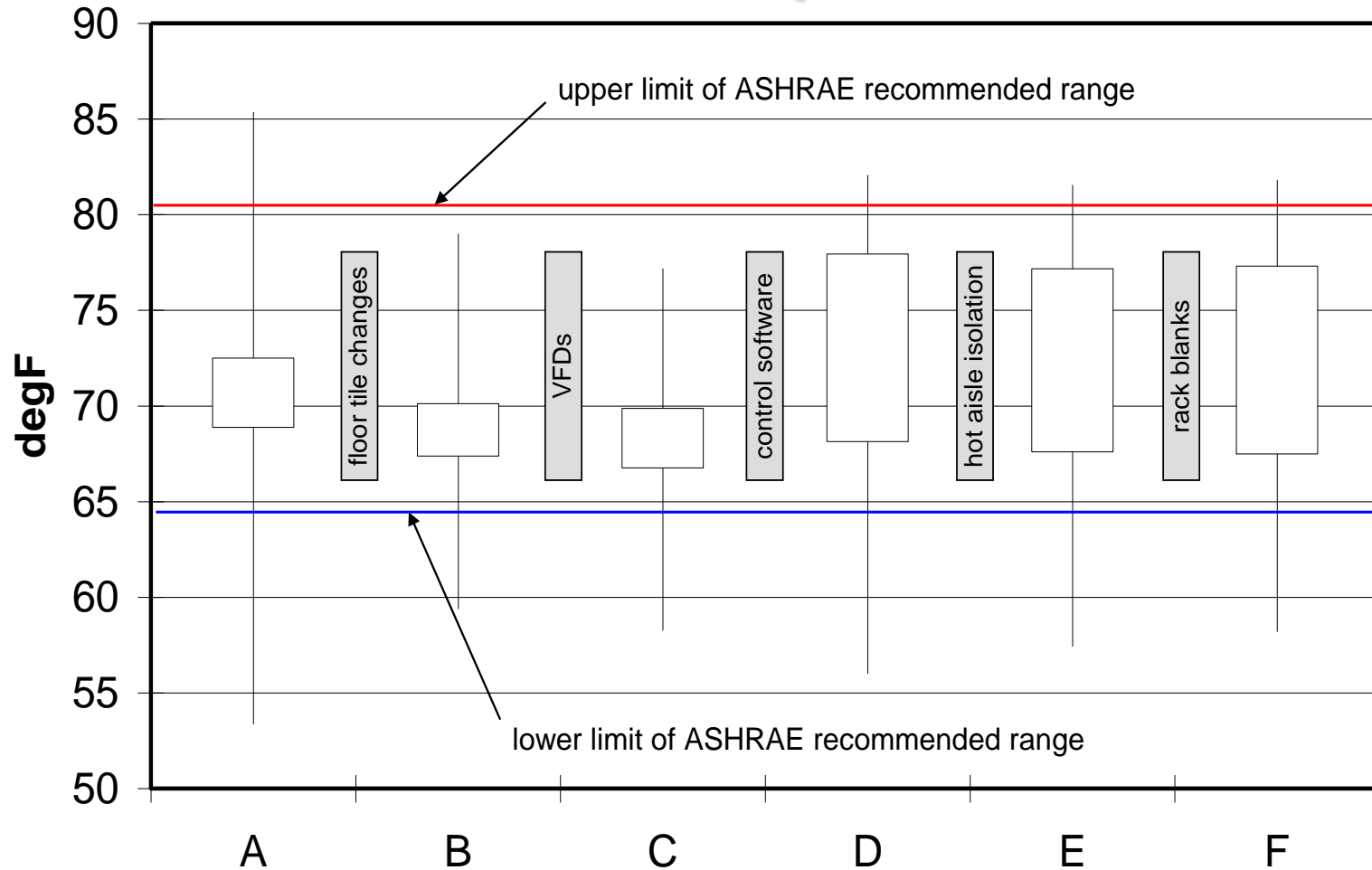
Dramatic load reduction
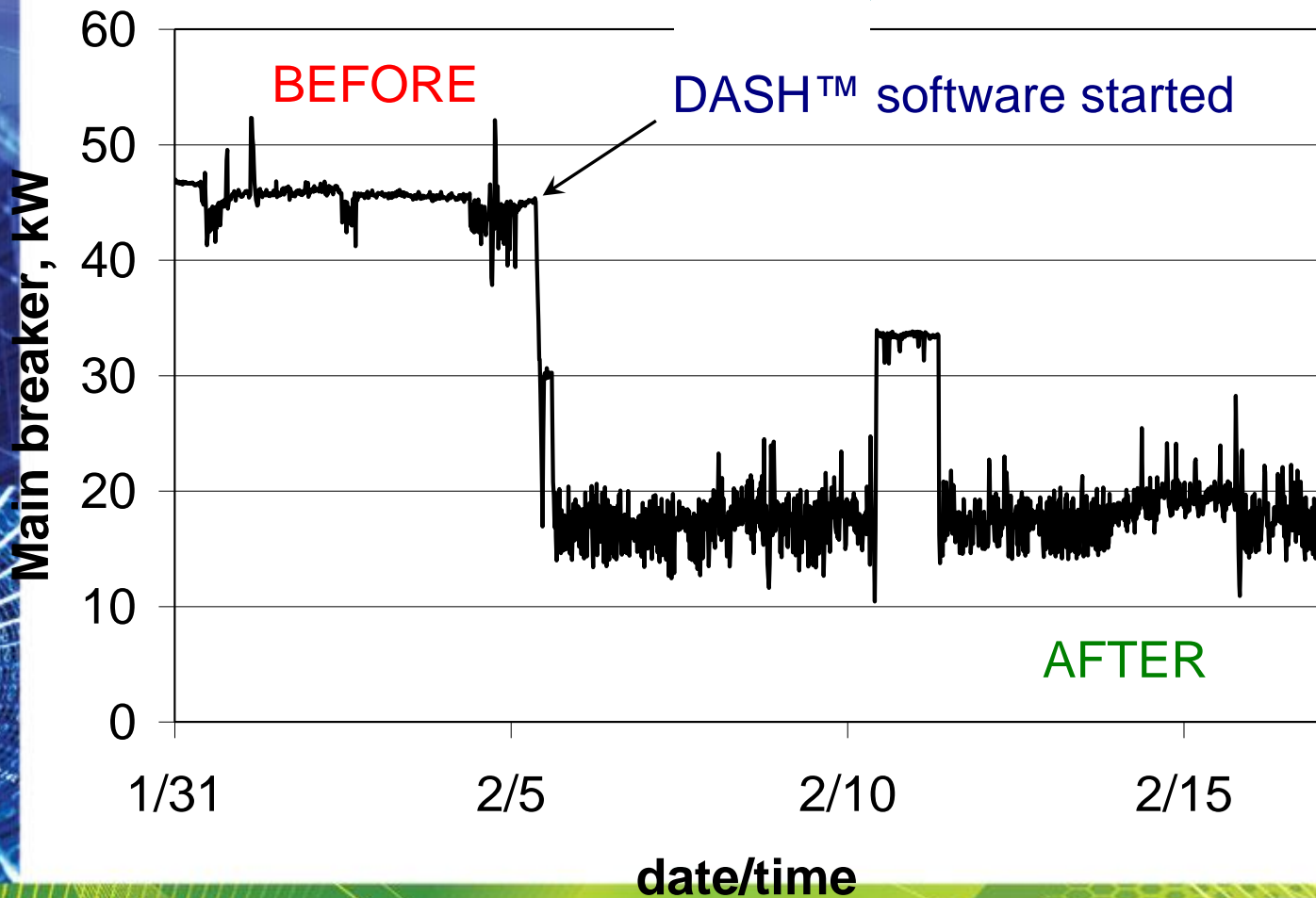
CRAH power reduction:
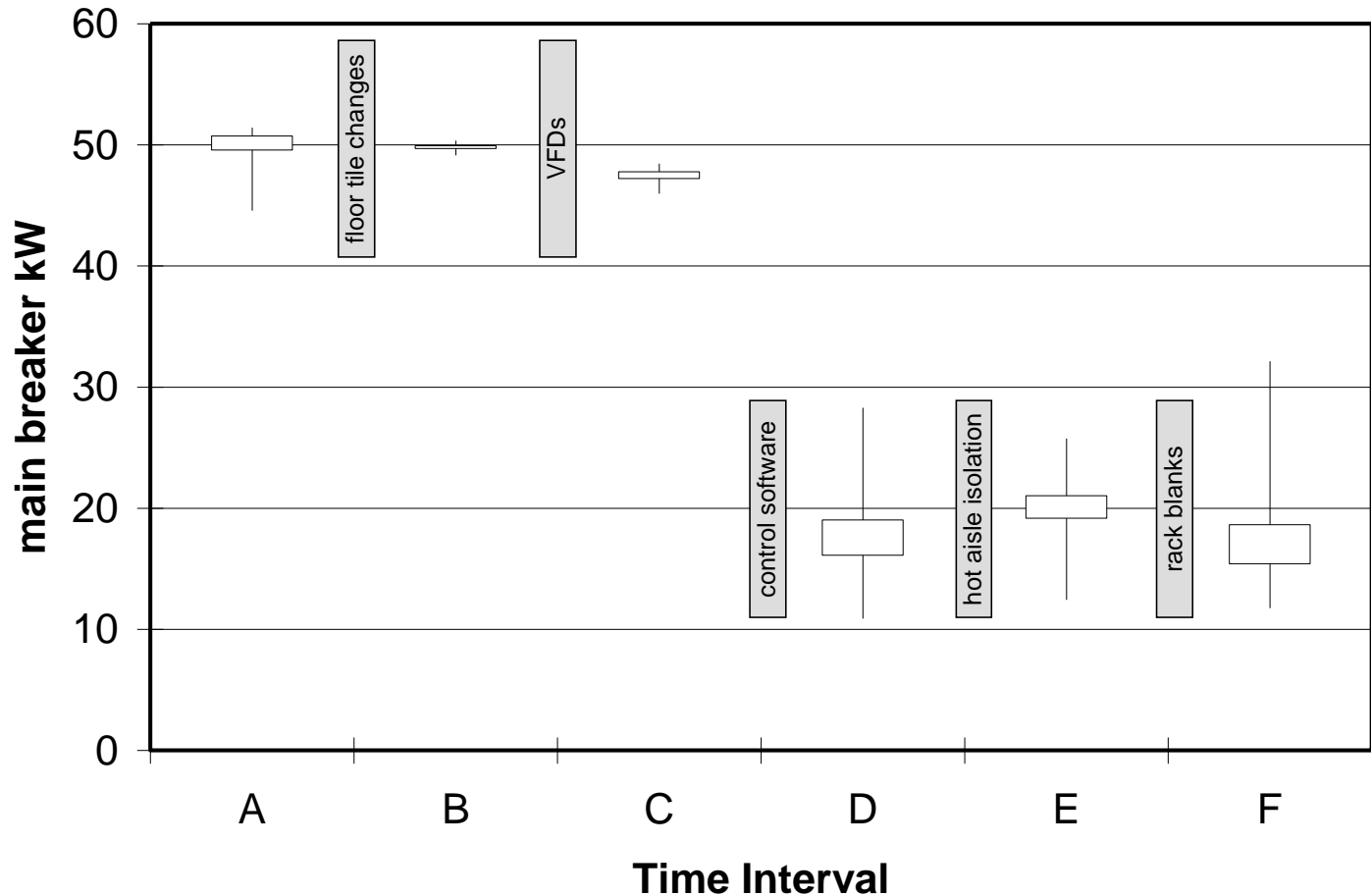
Cost-benefit analysis:

- **Total project cost-benefit**
    - **Cost: $134,057**
    - **Savings: $42,772**
    - **Payback: 3.1 years**

- **Cost-benefit (sensors and software)**
    - **Cost: $56,824**
    - **Savings: $30,564**
    - **Payback: 1.9 years**

Findings

- **Controls and software eliminated 59.6% of fan energy and 13.6% of chilled-water use from baseline.**

- **Re-arranging floor tiles reduced chilled water use and made cold-aisle temperatures more uniform.**

- **Variable speed fans reduced CRAH electrical energy use and further reduced chilled water use.**

- **Isolation enabled higher return air temperatures, increasing CRAH capacity.**

- **Wireless reliability was 99.999% (only 81 packets lost out of nearly 10 million sent).**

Integrated IT and facility monitoring and control

- IT equipment and building systems in general do not communicate with each other. Each is monitoring and controlling their separate functions. But they can be integrated.

- IT equipment monitors temperatures at several places in the equipment. Building systems monitor temperatures in various places. By integrating the systems, duplicate functions for temperature and power monitoring and control can be eliminated - saving cost and providing better control.

- The capability exists today although the industry needs to learn about it

Two industry teams demonstrated this technology for the Silicon Valley Leadership Group demonstration summit

- LBNL
- Intel
- IBM
- HP
- Emerson Network Power
- Wunderlich-Malec
- Fieldserver Technologies

- NetApp

- Cisco

Background:

Typically, data center air cooling equipment uses return air temperature sensors for the primary temperature control in the data center.
This allows inefficiencies:

- **Misperceptions of actual conditions**
- **No monitoring or control at IT equipment inlet air temperature.**
- **Too much, or too little, airflow provided to individual IT equipment.**
- **Overcooling or undercooling of specific IT equipment results.**

Evolution:

- ASHRAE Guidelines:
  Server manufacturers have agreed; main operational parameter is server inlet air temperature.
  - Server inlet temperature can be 80.6°F (27°C), yet CRAC *return* temperatures are often 65°-70°F (18.3°-21°C) and the supply is 10-15 degrees **colder**!
- Intelligent Platform Management Interface (IPMI): Server inlet air temperature is monitored and available from ICT network, either IPMI or SNMP (simple network management protocol).

All that is needed is to connect the two protocols.

IPMI or SNMP

Black Box

BACNET
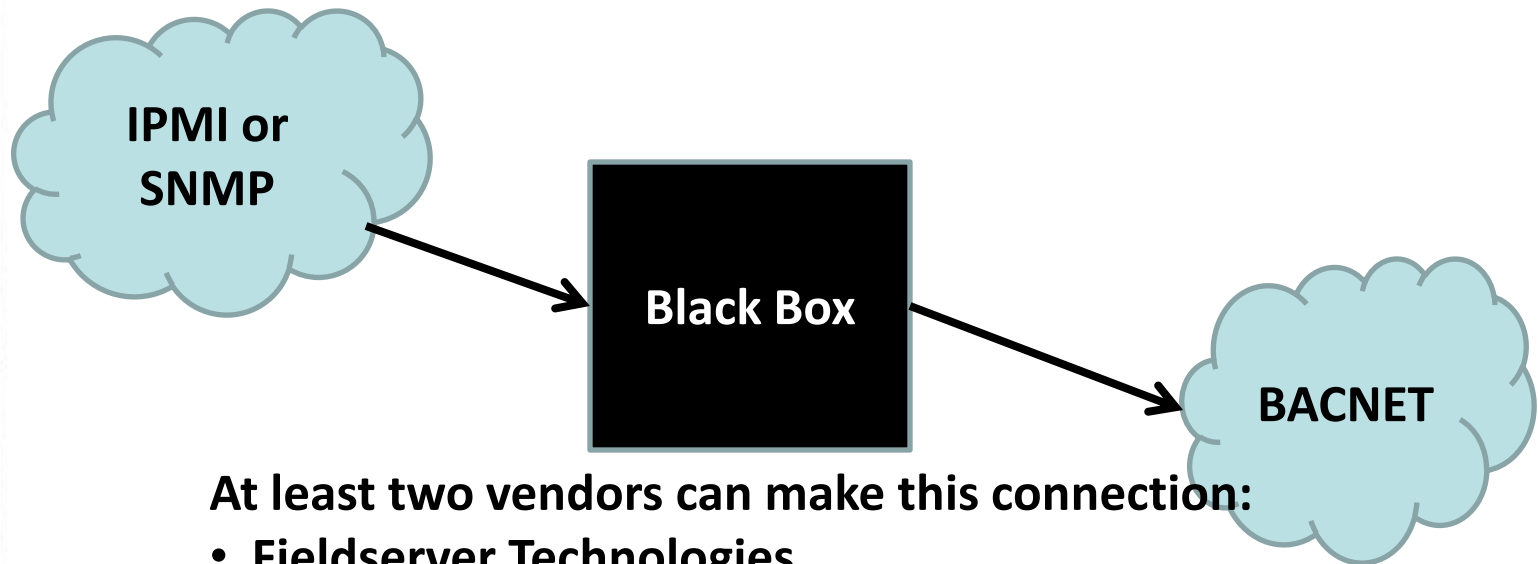
At least two vendors can make this connection:
- Fieldserver Technologies
- Cisco

Savings potential:

Reducing airflow:
- Match Server air flow with actual CRAH air flow,
  - As air flow decreases, Fan Power decreases at **cube rate** (Fan Law)
- Fan energy savings of 30 to 40%, or more, can result.
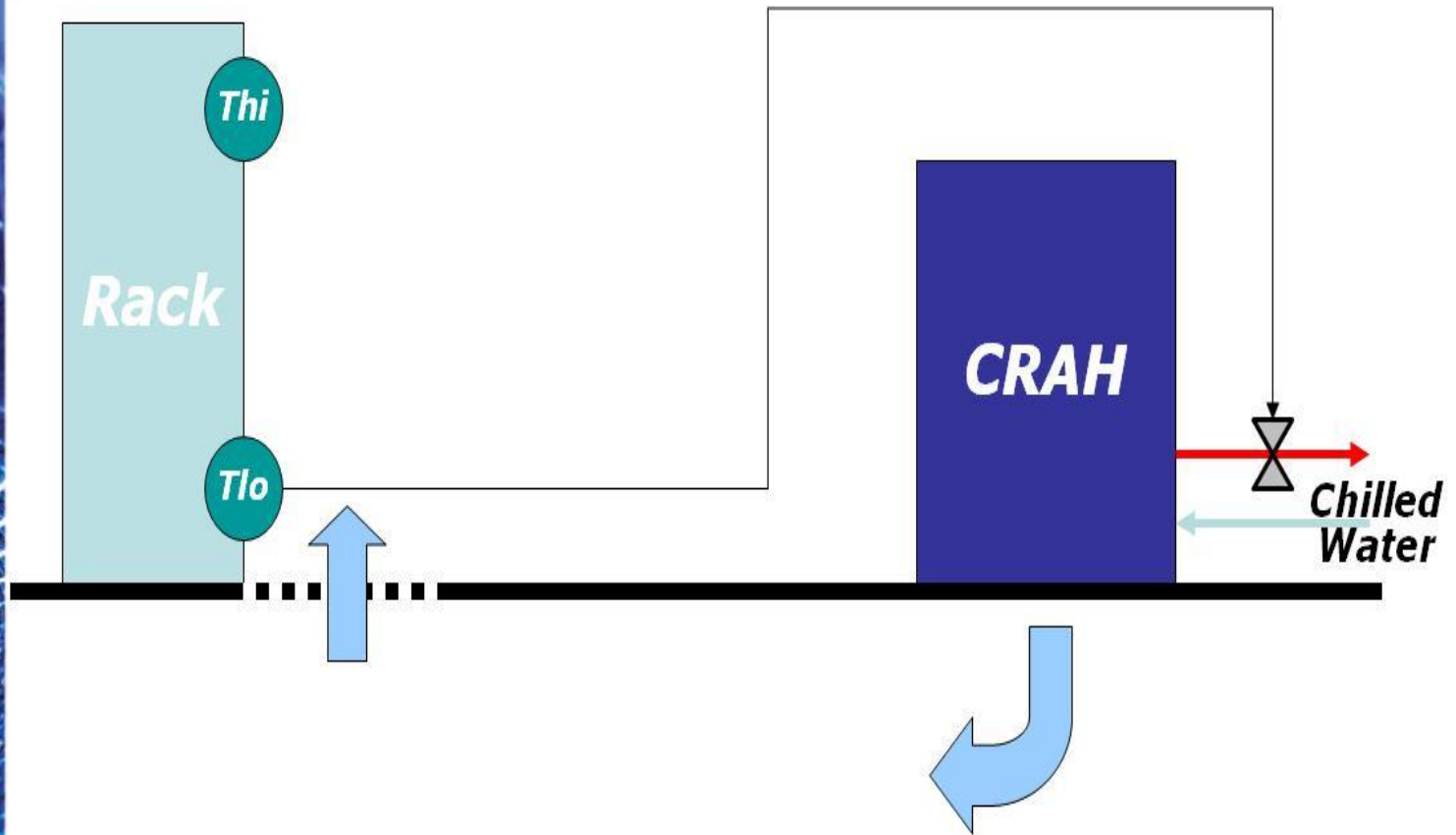
Increasing supply air temperature:
- Warmer temperatures significantly increase system efficiency.
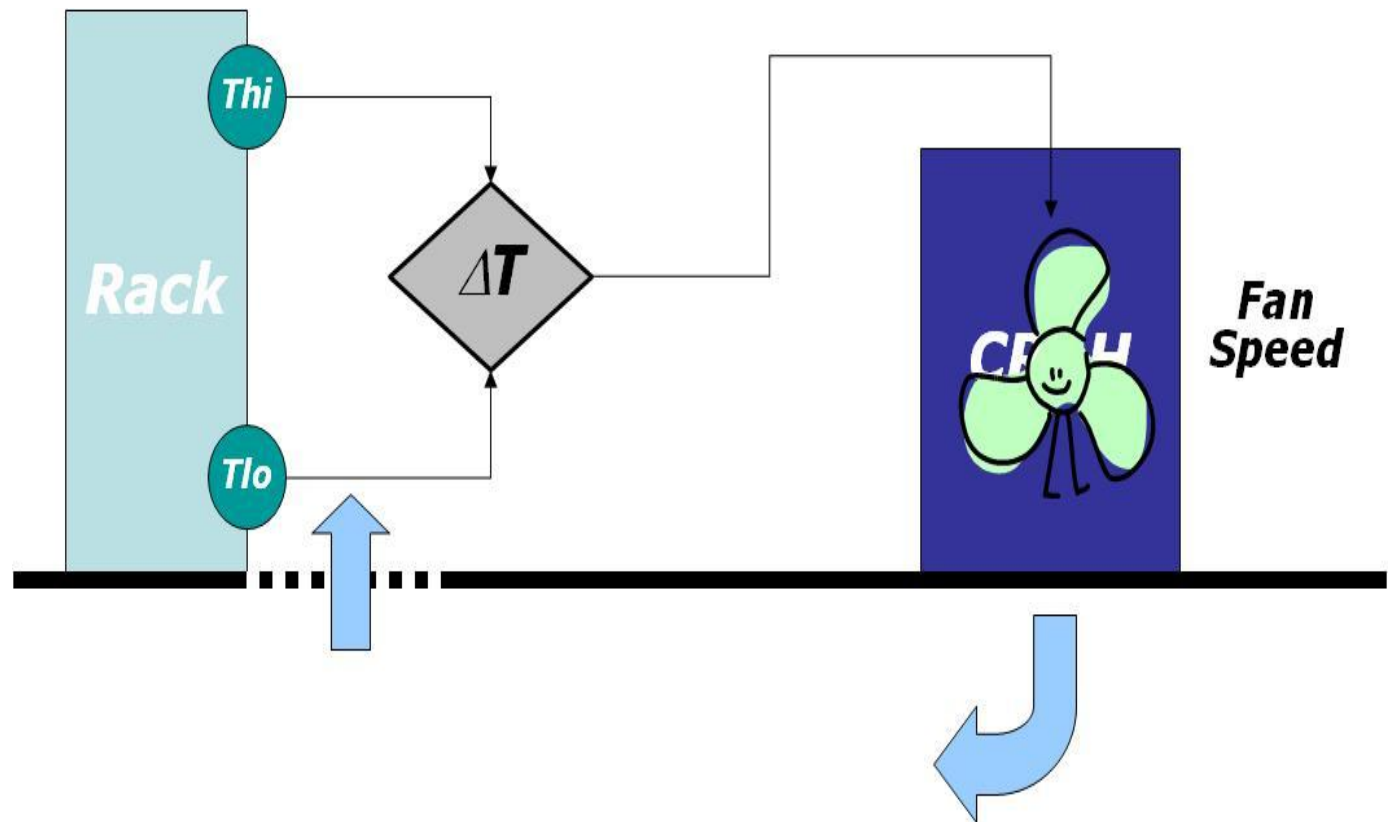- Chiller and pumping energy savings of 20% t0 30% can be achieved.

Chilled water valve position = $f(T_{lo})$
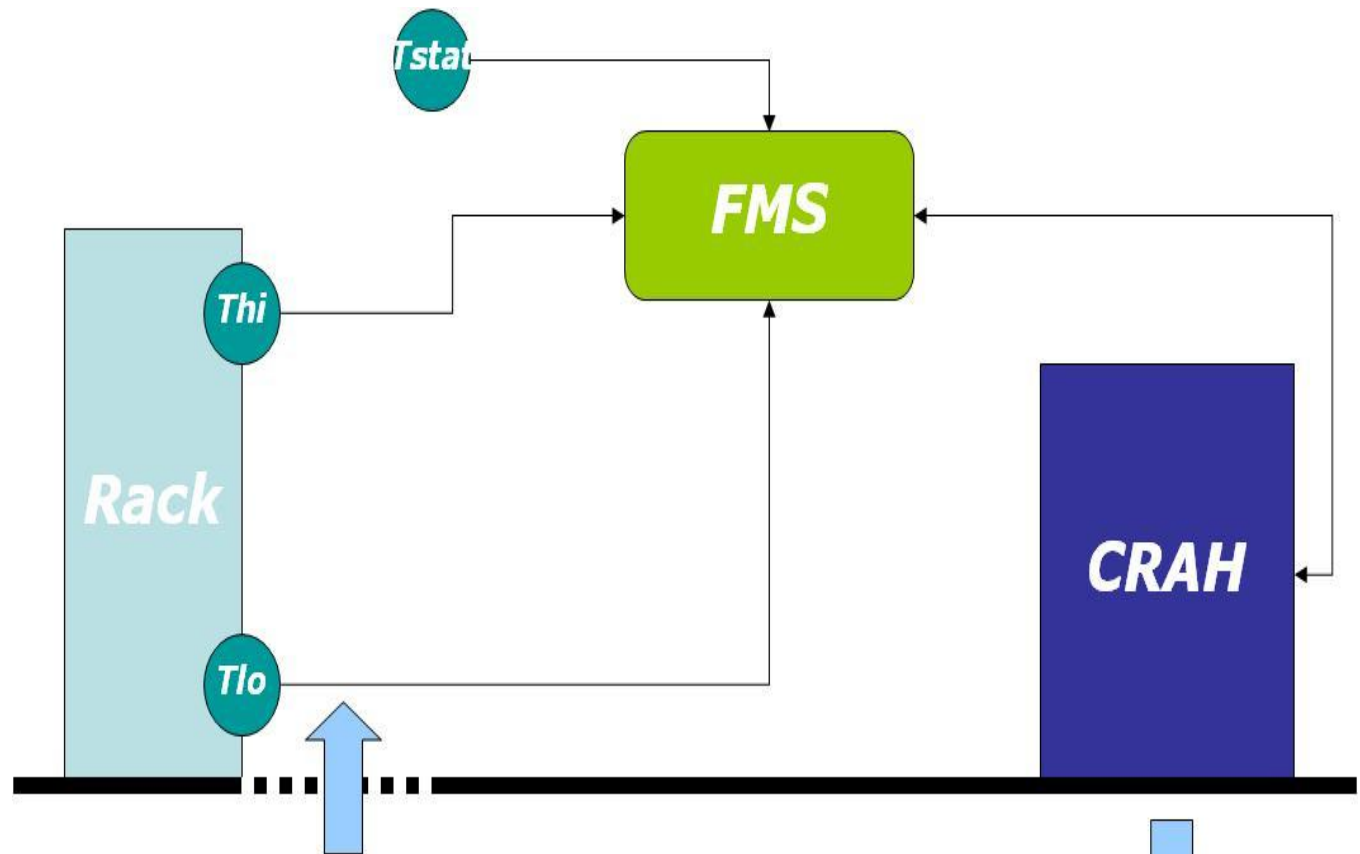
CRAH fan speed = $f(T_{hi}-T_{lo})$

Chilled Water valve position = $f(T_{lo})$

CRAH fan speed = $f(T_{hi} - T_{lo})$

Demonstration Conclusions

- Better controls can save significant energy
- Wireless solutions and integrating IT equipment with building systems can be implemented today
- Advanced controls can have short payback
- Integrated IT and building systems and their control has promise for further gains (e.g. eliminating fans, power supplies, etc.)

Questions?

**Bill Tschudi
Lawrence Berkeley National Laboratory
wftschudi@lbl.gov
510-495-2417**